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Opportunity

We're indebted to Melvin Calvin and his associates at the University of California for exposing, at least in part, one of nature's best-kept secrets—what goes on in photosynthesis.

They have shown us the precise chemical pathway along which a plant cell conducts atoms of carbon from the simple carbon dioxide of the air through a series of linkages to end up in relatively complex sugars. They have also shown that sunlight's part in this is to provide chemical reducing power and chemical energy necessary for the series of chemical changes.

Chemical reduction is the splitting out of oxygen from a molecule, making way to link on some other element or group.

It's still a question just how sunlight absorption by the green coloring matter—chlorophyll—in a plant cell sets up this reducing power and energy. The many scientists working on that doubtless will resolve the question—soon, we hope.

Consider that all plant life depends on the ability of green-pigmented plants to take carbon from the air and fabricate it photosynthetically into nourishment for the plant. No photosynthesis, no plant survival; no plants, no animals. Truly, photosynthesis is a key function in nature. Just a while ago man had only the vaguest conception of the process; now he has in his grasp discoveries of the highest magnitude.

Just how can we use this knowledge for man's benefit?

We want to know what makes plants efficient in building foods. We aren't interested merely in the complex end products. What about each intermediate stage in the production line? At what stage in the complex process of carbohydrate synthesis are the chemical changes made most efficiently—at what stage, least efficiently?

Suppose the scientists do learn how the reducing power and chemical energy of photosynthesis are generated. Then our understanding of those facts might enable us to grow plants more efficiently—better corn, wheat, and cotton.

The California discoveries give us a golden opportunity.

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PLOT AGAINST SCREWWORMS

livestock

Lessons from Curacao may benefit Southeast

CAN sterile male flies repeat their Curacao performance and eliminate screwworms from our Southeast?

Entomologists who successfully eradicated screwworms from the 170-square-mile Dutch island in the Caribbean in 1954–55 are considering using the same method to control or eradicate screwworms in the southeastern United States. Male flies made sterile by radioactive cobalt rays were dropped from planes to mate with native females (AGR. RES., October 1954, p. 8). But at least 2 more years of research are needed to learn if such a campaign would be practical in Florida, and to work out large-scale and cheaper methods.

Ideally, eradication should be undertaken after a very cold winter, when flies have been frozen out except in Florida's lower half. But since plans must be laid far in advance, workers must be prepared to produce enough flies to cover at least the average overwintering area, which extends roughly from Gainesville south.

Problems are essentially those of mass production. Since the method of eradication is new, entomologists have only their Curacao experience to guide them. To cover the Florida area, 50 million sterile flies must be distributed every week—250 to 300 times the weekly Curacao peak. Workers at the ARS entomology laboratory at Orlando, Fla., under direction of R. C. Bushland of Kerrville, Texas, want to learn to rear and sterilize flies on a pilot-plant scale first—say a million a week. Then they can multiply production by 50.

Research is needed to find a cheaper rearing medium, improve rearing methods to reduce the labor required, and streamline the various steps. Several "stink houses"—mass-rearing laboratories—will be needed. Rearing flies in small quantities is no problem; the maggots thrive on a body-temperature, odoriferous blood-horsemeat mixture. But large-scale operations, involving 20 tons of raw meat a week, require a great deal of planning and experimental work.

Giving each batch of flies a new cage cuts down the chances of disease spread. So an inexpensive, throw-away paper-bag cage, with screen-wire ventilation peephole, has been designed to hold the screwworm flies for 6 days until they lay eggs.

Several gamma-ray sources will be needed in Florida to sterilize pupae; only one reactor was used for Curacao. Recruiting and training numerous experienced entomologists and strong-stomached scientific aides cannot be done overnight. Planes must also be adapted. The distributing tube and hopper with flip-flop lid invented for dropping flies over Curacao was manually operated, requiring two people per plane. If engineers can devise an automatic distributor, pilots can do the job alone. Probably 35 small planes will be needed.

How many flies per mile should be dropped? Over what swath width? How often must releases be made? These are still unknowns.

One promising lead now being pursued might benefit southwestern as well as southeastern stockmen. The screwworm fly is attracted primarily to wounded living flesh or warm-blooded animals. The attractants that pull the flies to a wounded animal are suspected to be bacteria or bacterial decomposition products. Some 8 or 9 strains of attractive bacteria have been isolated from wounds—one strain so magnetic that flies laid eggs on it. The attractant cannot be reproduced artificially; but perhaps the attractive elements can be isolated and synthesized. Such material might be used as bait for a natural control, particularly in the Southwestern States where eradication seems to be out of the question.

If screwworms should be eradicated in Florida, could the Southeast be kept free of the pests? Entomologists think it possible. Natural spread seems to be largely northward, rather than eastward or westward; otherwise flies would spread from coast to coast. The southeastern infestation apparently stemmed from infested animals shipped in from the Southwest. State and Federal quarantines would probably need to be established along the Mississippi River to prohibit shipment of untreated livestock.

An attempt to eradicate screwworms in Florida would be costly. During some summers, however, flies from Florida attack livestock and wildlife as far north as New Jersey. They cause losses in the Southeast estimated at $10 million a year. Suppose an eradication program should cost $5 million. Even if the screwworm flies were not quite eliminated from this area, such a program would probably prevent enough livestock losses to pay for itself.

The Florida Cattlemen's Association and other livestock interests are vitally concerned with screwworms. The State of Florida has given USDA $25,000 for further research, and additional Federal funds have been allotted for the preliminary work that's now going forward.☆

GROUP LOOKS OVER BRUCELLOSIS CAMPAIGN

■ A FIVE-MAN advisory group is appraising our stepped-up Federal-State brucellosis campaign to determine whether adequate results are being obtained for the money spent.

An extra $15 million a year in Federal funds authorized by Congress for 1955 and 1956, plus $14 million a year now being spent by States, make it possible to double efforts to eradicate this livestock disease from the beef and dairy herds of the country.

Members of the consultant group are W. A. Hagan, dean of the College of Veterinary Medicine, Cornell University (chairman); T. F. Arnold, of Valentine, Nebr., rancher and vice-president of the National Brucellosis Committee; C. F. Clark, dean of the School of Veterinary Medicine, Michigan State University; W. D. Knox, editor of Hoard's Dairyman, Ft. Atkinson, Wis., and past president of the National Brucellosis Committee; and F. E. Price, dean and director of agriculture, Oregon State College. C. D. Van Houweling, director of USDA livestock regulatory programs, is the Department's liaison representative with the group of advisors.

Livestock organizations and other interested groups will be asked for their views, says Chairman Hagan.

Brucellosis (formerly known as Bang's disease or infectious abortion) is expected to cost United States cattlemen at least $45 million in 1955. Ten years ago, losses amounted to an estimated $100 million a year. Efforts to wipe out the disease have been underway since 1934, when 11 percent of the cattle tested in this country were found to be infected. At present it's believed that slightly less than 3 percent of our dairy and beef animals have the disease. Early eradication work was supported largely by Federal funds, but in recent years the States have devoted increasing amounts to the brucellosis fight.

Main features of the present eradication program are (1) testing to locate infected animals, (2) slaughter of animals that have the disease, and (3) extensive calf vaccination.

Brucellosis is still killing a quarter million calves every year before they are born. One-third of them are in beef herds. Infected cows produce a fifth less milk and 40 percent fewer calves. USDA scientists believe, however, that the tools provided by research will enable us to eradicate this costly disease in the United States. The current Federal-State brucellosis program aims at this goal.☆

RESEARCHERS STUDY NEW CATTLE DISEASES

■ SEVERAL apparently new diseases are attacking cattle in at least 20 States, and veterinarians in USDA, State, and private organizations are cooperating to determine the causes and develop control methods.

So far, these livestock diseases have shown up in various forms under such names as viral diarrhea, mucosal disease, and rhinotracheitis. Pathologists have determined that viral diarrhea as observed in New York, Indiana viral diarrhea, and mucosal disease in Iowa are different diseases in that none of them produces immunity to any of the others. But they are considered related and are referred to as the mucosal complex. The rhinotracheitis reported in Colorado and California, on the other hand, is generally thought to be the same disease in both States but different from the mucosal-complex diseases.

In all of them, affected cattle eat reluctantly and lose weight. Mortality varies greatly. Antibiotics have been helpful in only a few cases, but they may effectively combat secondary conditions that develop following exposure to one of the diseases.

Pathologists have not identified the causes of these diseases. All can be transmitted from one animal to another, indicating they are infectious and may be viral in character.

Research workers and regulatory officials have met and recommended several measures to aid in further study of these diseases. Under these proposals, ARS is to: (1) contact all laboratories working on the new diseases to determine the approach being used; (2) act as a central point for exchange of information; (3) select two laboratories to identify suspicious materials—one for the viral-diarrhea or mucosal diseases, one for the upper respiratory form; (4) determine the extent and seriousness of infection in various States; (5) recommend control measures if needed; and (6) appoint a committee to coordinate control efforts and determine sources of funds available for the support of diagnosis and research work.

Further research to determine the causes of the diseases and how they are transmitted and to develop immunizing agents will be undertaken as a basis for control measures.☆

Three Diseases-One Cotton

BREEDERS ARE PUSHING TOWARD THE GOAL OF VARIETIES THAT HAVE THREE-WAY RESISTANCE

RESISTANCE to three major cotton diseases—combined in a single variety—may someday be available to farmers in the seed they buy.

These diseases—verticillium and fusarium wilt, and root knot—now cost more than $100,000,000 annually. Although some varieties are now resistant to one or another of these diseases, this helps little in areas where all three are present.

New three-way resistant varieties are being developed by ARS and cooperating Mississippi experiment station scientists at State College, under ARS plant pathologist A. B. Wiles. Success of this venture will mean that farmers will then be able to buy resistance to all three diseases in the variety of cotton they want—for the price of the seed alone.

Results are beginning to show after 3 years of effort. High tolerance to verticillium wilt has been found in varieties such as Auburn 56, Alabama Hybrid 257–202, Alabama Hybrid 81–14, and Hartsville. Many other commercial varieties proved to be susceptible to this wilt, even though some resisted fusarium wilt.

Fusarium-wilt-resistant cotton has been available for some time. But scientists are now attempting to incorporate a higher degree of resistance in some of the more common commercial varieties. Sources of high resistance have been found—the next step is to find how it's inherited. Breeding materials are also being tested for desirable agronomic properties such as earliness, yield, plant type, and fiber quality.

In the search for resistance to root-knot nematodes, researchers have found varying degrees of susceptibility in our commercial varieties of cotton. This has been indicated by the development of fewer root galls in some plants than in others. The aim, however, is to breed into commercial varieties the resistance to these nematodes that researchers have found in some wild species of cotton.

Screening tests to determine wilt disease tolerance or susceptibility in cotton breeding material have been speeded up at State College by the use of young cotton seedlings. This method provides a far more rapid turnover of plant material than the use of mature plants. It also gives a more dependable picture of disease reaction than researchers have been able to obtain in field outbreaks.

The seedlings are grown in greenhouses in flats of sterilized soil. In the three-leaf stage, the young plants are lifted one by one with a trowel, dipped in a suspension of wilt-disease organism, and reset in the same spot. At favorable temperatures, disease reaction occurs in about 6 weeks. Only tolerant plants are kept for further observation and use.

Field-testing of disease-tolerant plants follows. Some 15,000 will be field-tested at State College this year for verticillium wilt alone. Other Federal and State stations aid in this work. California and Arizona stations, for example, are field-testing cotton plants from State College greenhouses this year to determine whether the tolerance of these plants is maintained over a wide range of field and climatic conditions.

Efforts made so far are only the first steps. Work to follow will include development of new varieties from resistant commercial and wild strains already found. Through crossbreeding and selection of these strains, scientists hope to develop progeny with three-way resistance. If they succeed, they will cut cotton farmers' mounting disease-control bill.☆

REACTION of cotton seedlings dipped in suspension of verticillium wilt organism is pictured below. Plants in the first four rows are tolerant to the disease; plants in the last two rows are susceptible.

HEALTHY cotton seedlings below were grown in sterilized soil and dipped in sterile water rather than the verticillium wilt inoculum. Use of seedlings in screening tests has proved rapid and dependable.

OUR SEARCH FOR PROBLEM SOILS

We're finding that abnormal content of trace minerals in many soils is affecting plant and animal nutrition

OUR soil types—their content of major mineral elements and their productivity—have been largely outlined through half a century of soil surveying. Now, USDA has turned to locating soils that have an abnormal content of trace minerals that affect nutritional quality of foods or feeds grown on those soils.

It's only a start, but important. (Some of the consequences of soil-mineral abnormality were reported in "Our Food Quality Frontier," AGR. RES., October 1955, p. 3.)

The effect of soils on nutritional quality of crops first attracted attention through nutritional diseases of men and animals whose diets originate locally. It's a familiar story that human goiter was traced to iodine-deficient crops grown on low-iodine soils. Those soil areas now are largely delineated. They're in the interior of the country. But other human-disease links to soil aren't so evident because modern man tends to gather his diet from the four corners of the land—from many soils.

Livestock is a better indicator. Since farm animals generally feed from a single farm, they may have a nutritional disease directly traceable to that farm's abnormal soil. This fact helped scientists link runtiness of ruminant animals in some eastern localities to cobalt deficiency existing in the soils and crops there.

With such clues, K. C. Beeson, director of the ARS Plant, Soil, and Nutrition Laboratory, Ithaca, N. Y., and North Carolina experiment station researchers spot-checked suspected areas and analyzed crops for the trace of cobalt they contain.

Measuring trace elements is a slow precision job. The scarcer the element, the more exacting the job. So Beeson joined V. A. Lazar and S. G. Boyce, of Ohio University, in search of better indicator plants—species that store micronutrients plentifully and proportionally to their content in the soil. Swamp blackgum and pepperbush are good indicators of cobalt, zinc, copper, and manganese—gallberry and sweet bay, good indicators of zinc and manganese. This finding gives greater speed and assurance in tracing problem soils. And the help of other stations should greatly expedite the search.

Spot checks show cobalt is deficient in many localities from the Upper Great Lakes eastward and southward to the Gulf. We should be able to pinpoint our areas of severest cobalt deficiency within a matter of years, rather than decades, as recently seemed the case. The cobalt needs of our feed crops are being worked out. Correction by supplementing our deficient soils or feeds with cobalt may become standard practice in the forseeable future.

The indicator-plant approach is encouraging. Selecting the indicators is more complicated, however, than merely finding what plants are heavy users of a particular mineral. Beeson and Cornell agronomist H. A. MacDonald found that mineral content may vary quite a bit in a given species depending on its stage of maturity and also on the part of the plant that is being tested.

Timothy has its greatest copper content early in growth, approaches maximum for manganese at midseason, and is richest in manganese, iron, and cobalt—but poorest in copper content—late in the season. Legumes are richest in iron and copper at mid-bloom stage. It's important to understand each species' maturity factors relative to each mineral and to test plants at their best stage.

The nutrition staff still gets most of its guides to problem areas from other scientists who have observed nutritional ailments in animals. Some of the most spectacular problems are the mineral toxicities reported from western range lands. Beeson has spent most of the past summer with a party of scientists investigating toxic conditions of cattle and sheep in Utah and Idaho.

Veterinarians Wayne Binns and W. T. Huffman (retired), of ARS, animal nutritionist L. E. Harris, of the Utah experiment station, and Bee-

son visited high mountain ranges in Utah. Cattle and sheep there are subject to the deformity, big brisket disease, and to other forms of malnourishment. In Idaho, mountain-valley meadows were studied in connection with lambs born with extremely deformed heads. The disease is sometimes called monkeyface.

Molybdenum toxicity of livestock previously had been identified with plants growing in high-molybdenum soils in some of these areas. So that or some other mineral toxicity was suspected. Soil scientists W. O. Robinson and J. Kubota, of the Soil Conservation Service, and Beeson extensively sampled the vegetation and soils on these problem ranges.

Samples analyzed from a 1954 trip to the same general areas proved inconclusive. This showed a need for good indicator plants and a reliable sampling procedure for each mineral in question. Beeson hopes to learn whether selenium and molybdenum build up as plants get older, and also whether the soil abnormalities are spotty, as the scientists thought.

In some places vegetation grows largely on powdered rock, rather than soil in the usual sense. These materials are very high in molybdenum, selenium, uranium, vanadium, and iron. Molybdenum and possibly iron interfere with the animal's important storage of copper in the liver. On copper-deficient soils, these interferences are increased.

Peat beds are fairly common in poorly drained spots. In many cases these beds—likely sites of mineral abnormality—afford the only browse in summer droughts. It is thought that seepage into these low spots carries a toxic element, which thus accumulates and is absorbed in large quantities by the vegetation.

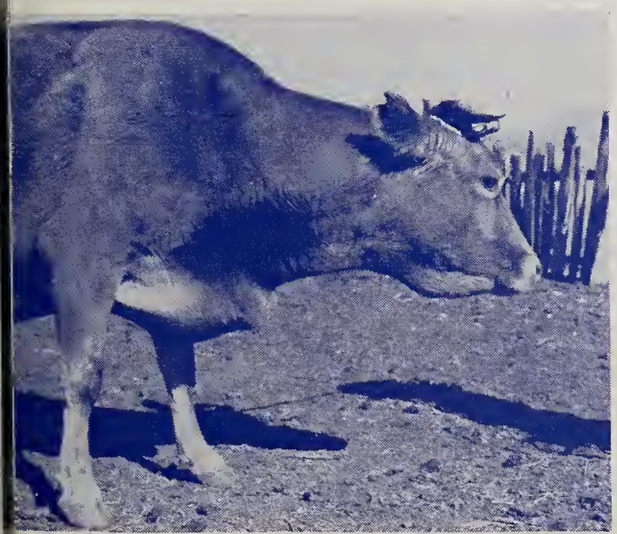
For the country at large, boron is the one micronutrient most generally deficient with respect to crop yields. It's short throughout New England and in many other eastern areas. Zinc is low in many soils of the Southeast and West Coast. Manganese deficiency, on the other hand is not frequently found in nature, though too much calcium keeps plants from taking up enough manganese.

In studying the South Carolina Coastal Plain, the nutritionists found that land form and geology have something to do with the amount of calcium, phosphorus, cobalt, copper, iron, and manganese in the soil. Low plains at 25 to 42 feet above sea level had a very low content of these elements, whereas lands at 100 to 170 feet elevation were somewhat better supplied. Two river basins in this area were generally low in phosphorus, cobalt, copper, and iron, but high in calcium and manganese. Findings such as these lead to shortcuts and should expedite survey work.

One of the biggest advances so far in expediting survey work is a new quick plant-assay technique adapted by C. S. Brandt for the laboratory. Specimens of plant material, reduced to ash, are exposed to an X-ray spectograph. The rays are refracted to a different degree by each mineral in the plant and are thus arrayed in light bands. The instrument identifies each band by wavelength with the mineral that caused it and measures the element's concentration. This method opens the way for large-scale testing and mapping problem soils.

It's a big job locating soils abnormal in trace minerals. The nutrition staff hopes that as it opens up new problems and finds new criteria, to aid in the search, other agencies will find the problem areas.☆

BIG BRISKET of cattle on some high Utah ranges points to complex organic disorders. It looks like plant poisoning. Excesses of molybdenum, selenium, uranium, iron, and possibly other soil minerals, or deficiencies of copper or cobalt may have a bearing.



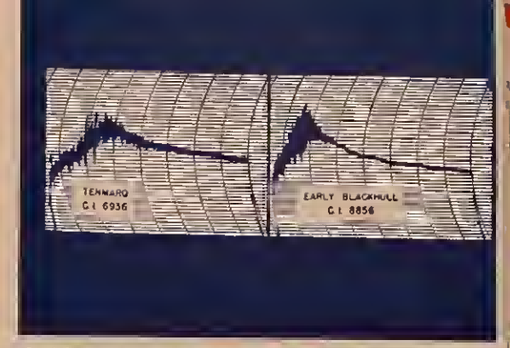
GROTESQUE HEADS of newborn lambs are another mysterious sign of a faulty environment. Monkeyface occurs on only a few Idaho ranches. Flocks similarly situated elsewhere don't have the problem. Soil and plant life in the affected areas are being studied to see whether there's an excess or deficiency of any minerals that could cause plants to accumulate toxic amounts of some elements.

Wheat - FROM BREEDER TO BREAD

1. Experimental milling of wheat gives information on milling behavior, flour for baking tests. Characteristics of good bread wheat: grain that is not too hard, not too soft; flour that sifts freely and evenly; good yield of flour with low ash.

2. Protein content of a wheat is determined chemically, is one of the best single indexes of breadmaking quality. About 80 percent of the difference in breadmaking quality may be due to protein quantity and 20 percent to protein quality.

3. Mixograph records a curve of how flour reacts to mixing with water to make dough. Dough that develops too fast may be damaged if it is mixed longer than necessary. Bakers want flour that makes dough not easily harmed by overmixing.



4. Mixograms compared: Dough from a good bread flour (left) takes longer to reach peak, shows continued movement. Dough from a poor bread flour (right) hits peak fast, drops suddenly, has little further movement.

5. Baking bread is final test. In early stages of developing a new wheat, only enough grain is available for the small micro loaf (12 grams—0.4 ounce—of dough). Later, pup loaf (180 grams), standard commercial loaf (18 ounces) are tested.

6. Volume of test loaf is med by the seed-displacement method. Good loaf volumicates flour contains enough gluten protein to retain gas ated in fermentation. This is known as a "strong" flour millers pay a premium for it.

7. Experienced judges score the bread on appearance of loaf, color of crust, symmetry of form. The bread is then cut and scored for internal characteristics such as color, grain, and texture of crumb. Numerical values are used in scoring.

8. Bread F, from a strong flour, has high loaf volume, good grain and texture. It's well shaped, smoothly developed. The poor appearance, low volume of Bread H indicate it was baked from flour low in gluten strength.

New vaes must meet many a milling and baking test before they reach our farms

WILL a new wheat variety developed to resist disease, insects, drought, and frost make good bread? The answer is important because half our wheat crop (about 1 billion bushels) is milled into flour for domestic use. This flour is baked into about $5 billion worth of bakery products, plus homemade breads and pastries.

Cereal chemists and bakers at cooperative USDA and State experiment station laboratories begin studies of the milling and baking qualities of new varieties as soon as enough material is available. Breeders then select only the better ones for further planting testing.

Extensive milling and baking tests are made before a new wheat is released. Collaborators associated with commercial use of wheat assist in these studies.

Recently when race 15B of stem rust seriously threatened hard red spring wheat, the Willet variety was selected from a cross of Fontana × Thatcher—combining good resistance to leaf rust and to stem rust. Willet also yielded well. But milling and baking tests, in which the Northwest Crop Improvement Association and other cooperated, showed that dough made from Willet flour had poor handling qualities (it was sticky and broke easily). Also, the dough developed too rapidly and was easily damaged by overmixing—qualities undesirable for commercial baking. So Willet wasn't distributed.

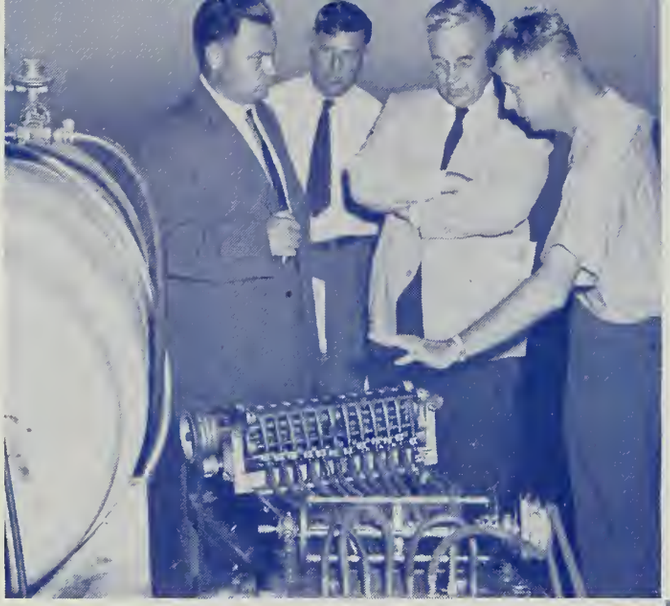
To meet the emergency, large quantities of Selkirk seed were released to growers. Also a hard red spring wheat, Selkirk was selected from a different cross. This variety had only moderate resistance to 15B stem rust—but possessed good baking and milling qualities.

For several years, our cereal chemists have been trying to develop simple objective methods to determine the quality of wheat and flour. Researchers now use a number of tests, including simple physical and chemical tests, tests for protein or gluten quality, and physical dough tests. Baking finished products, however, is still considered the final criterion of wheat quality.

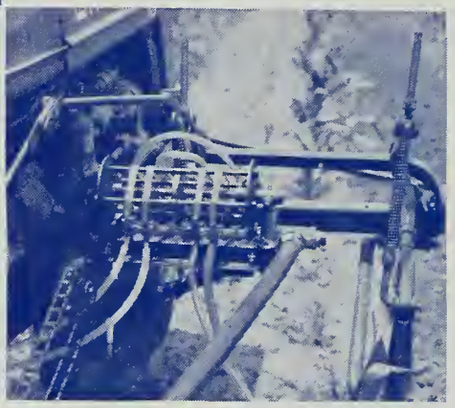
More recently, application of the fractionating-reconstituting technique to wheat is helping researchers to find out what parts of the wheat are responsible for variations in baking properties. By this method, wheat is separated into starch, glutens, and water soluble fractions—then put together again in the original ratio as well as in a number of new proportions. The reconstituted flours, along with the flour as it was originally milled, are made into bread and other bakery products.

Wheat varieties are classed according to the season when they're grown and the use for which they are best suited. Hard red winter wheat (roughly about 50 percent of all wheat grown) and hard red spring wheat are suited especially for bread flour. They contain a relatively large amount of strong, elastic gluten (protein) essential for the best bread. Soft red winter and white wheat flours, both usually low in protein, are used for pastry, crackers, biscuits, cookies, and cakes. Durum wheat goes into macaroni, spaghetti, and similar products.

Studies of new varieties are conducted cooperatively by ARS and State experiment stations at regional wheat-quality laboratories. At Manhattan, Kans., researchers test hard red winter wheat; at Wooster, Ohio, soft red winter wheat; and at Pullman, Wash., western wheats. Hard red spring wheat and durum wheat quality studies are made at the cooperative Agricultural Marketing Service and ARS laboratory at Beltsville, Md.☆



PILOT MODEL of liquid-nitrogen applicator is viewed at Agricultural Research Center, Beltsville, Md., by Russian farm experts on their visit here. ARS engineer W. C. Hulburt is explaining this model to Russians Aleksandr Ezheviski and Andrei Shevchenko, and translator Eugene Serebrennikov, from Library of Congress.



APPLICATOR is in use here as an attachment to tractor-mounted 2-row corn cultivator. Plastic hoses carry liquid nitrogen from a storage tank (not shown) to both sides of rows.

NEW WAY WITH LIQUID N

Low-cost applicator puts this economical fertilizer within reach of small farmers

GREATER use of liquid nitrogen is expected to result from the development by USDA-State research of an inexpensive machine to apply this low-cost fertilizer. Previously, use of liquid nitrogen, as well as other plant nutrients in this form, was generally limited to larger farms that could afford to own relatively high-cost applicators.

The new applicator, as improved and modified by engineers of ARS and the North Carolina experiment station, can be manufactured within a cost range of $100 to $200. This brings the machine within reach of our smaller farm operators. Models of the machine in various sizes are being offered by a manufacturer who cooperated in its development.

Liquid nitrogen has the advantages of being easier to handle and lower in cost per unit of plant nutrient, compared with dry fertilizers.

The new machine not only answers the cost problem of liquid-fertilizer application but also features simple design and operation, inexpensive upkeep and repair. It is capable of handling either non-pressure or low-pressure nitrogen solutions or other fertilizers of this type.

This machine uses plastic hoses fed by gravity from a storage tank. The hoses (1 to 12 or more may be used) are placed snugly around a four-roller reel. Power transmitted from the machine's ground wheels, linked by chain and sprockets, revolve the reel. As the reel turns, the rollers compress the hoses, exerting pumping action on the liquid.

Booms to which the hoses are fastened carry the liquid to the crop rows for placement as desired. The hoses can also be attached behind cultivator shoes, plows, or various types of fertilizer-applicator shanks used for subsurface application.

C. W. Gantt, Jr., ARS engineer at Beltsville, Md., who cooperated in the improvement of the machine, points out that no valves are required to start or stop the flow of liquid. The reel rollers compress the hoses sufficiently to stop the flow when the machine is not in motion. Forward motion, however, causes the pumping action to start immediately.

Positive and accurate measurement or metering of the liquid is made possible by the machine's pumping action. This can be governed by changing the speed of the reel in respect to the ground wheels. The ground speed of the machine itself does not affect the rate of application.

Because liquid fertilizer is handled by the new machine without coming in contact with moving metal parts, corrosion is not a problem.

The new machine embodies the basic principles of an applicator designed cooperatively some years ago by the Tennessee Valley Authority and the Tennessee experiment station. The earlier version, however, failed to win commercial acceptance, largely because the rubber hoses used in that model wore out too quickly. Plastic hoses used in the new improved model provide far greater elasticity and durability. And this greater durability results in lower upkeep cost.

Cost studies made at the North Carolina Station show that the owner of a liquid-fertilizer applicator costing $100 can break even with about 12 acres of annual use, compared with the cost of custom application. If the machine cost is $200, the break-even point is about 22 acres.☆

ALFALFA CAN GET ALONG WITH GRASS

■ RESEARCH HAS PAVED the way for better pastures in the Northeast.

The big difference will likely come through growing alfalfa successfully with grasses for pasturage.

In some areas, alfalfa is already being used in pastures. Easterners, however, have known it almost exclusively as a hay crop. But alfalfa has proven ideal in combination with pasture grasses in experiments at State College, Pa., carried on cooperatively by USDA's Regional Pasture Research Laboratory and the State experiment station. Contrary to wide belief, properly-managed alfalfa withstands pasture traffic well. It also gives a better seasonal distribution of grazing than traditional pastures, as well as more nutritious forage throughout the season.

Farmers respect alfalfa's high quality—also its dependability even in dry weather. Alfalfa has a deep root system and grows long after the upper soil is dry. However, an important grazing advantage—one not widely appreciated—is alfalfa's ability to resume growth promptly after cutting or grazing. This is due in part to the plant's method of storing nutrient reserves for future growth. They're stored in the plant *root* and *crown*. That's important for this reason: after removal of *foliage*—the plant's manufacturing center—the plant must start rebuilding with previously-made nutrients.

In testing alfalfa as a pasture plant at the regional laboratory, ARS plant physiologist V. G. Sprague found that alfalfa has some advantages over other legumes used in the area. It affords an exceptionally good supply of high-quality feed in a mixture. It reproduces well despite dry weather. It can be counted on during July and August, when pastures tend to run low. And it can be kept in vigorous condition for several years.

Alfalfa success depends on allowing time after forage removal for adequate regrowth and replenishment of reserves before grazing again.

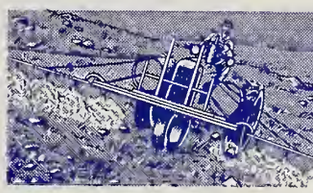
The first cutting of alfalfa, or equivalent grazing, may be made when the plant is in *full bud* rather than waiting until the customary one-tenth-bloom stage. The earlier cutting permits grazing earlier in the summer and also an extra grazing during the summer when pasturage is frequently short. In the experiments when Sprague cut alfalfa in the bud stage in May, he got some less hay (dry weight) but much better quality. The yield loss wasn't entirely made up during the summer, but grazing started earlier—gave some 10 days more of hot-weather grazing.

It's important to let alfalfa start to bloom before a late-August or early-September grazing. If not in bloom by then, it shouldn't be grazed until middle or late October.

When tried before in the East, pastured alfalfa usually decreased in production—thinned out in stand in at year or two—because it was not allowed to recover enough between grazings. After the original cuttings, Sprague allowed the stand to recover until the alfalfa started to bloom again—in about 4 weeks—and it was ready for 7 to 10 days good grazing. This permitted 4 grazings instead of 2 or 3, and a satisfactory stand was maintained 5 years or longer.

A joint technical committee of ARS and the Northeastern experiment stations coordinates this work with State studies that are designed to adapt the method to local situations.☆

HERBICIDES CAN HELP REBUILD PASTURES



■ RECENT RESEARCH FINDINGS make it practical to rebuild many of our low-capacity native pastures with productive grasses and legumes.

The problem is to prepare economically a nonerosive seedbed on rough or steep land. It's difficult and costly to eradicate weedy grasses and plants with conventional methods of seedbed preparation. But undesirable grasses can be destroyed by selective herbicides and the land prepared well enough for a reseeding operation by disking the field 2 or 3 times.

New Jersey experiment station and USDA scientists found the new herbicides DPA (2,2-dichloropropionic acid) and AT (3-amino 1,2,4-triazole) kill grasses—but not other weeds and brush. Unlike other successful grass killers, these are economical to use.

Six to 8 pounds of DPA or 4 to 8 pounds of AT per acre—applied one month before fall seeding or applied in November before spring seeding—cleared the way for successful seedbed preparation and seeding of new grasses and legumes. A mixture—2 pounds of DPA and 4 pounds of AT—proved to be even more effective.☆

Frozen poultry: temperatures and quality

■ FROZEN POULTRY is subjected to complex temperature patterns as it is chilled, frozen, stored, transported, and finally held in retail display cases and home refrigerators.

Although the importance of low-temperature storage for top quality is recognized, little detailed study has been devoted to the effect of temperature variations on the quality of frozen poultry. Accordingly, scientists at USDA's Western Regional Research Laboratory inaugurated a substantial program to study these effects.

In the initial phase, the researchers set out to answer two questions: How does storage under fluctuating temperatures affect quality? Is this more detrimental than storage under a steady temperature?

Some answers are now becoming apparent. With a moisture impermeable package and a temperature range of −10° to +10° F., frost accumulation in the package is the only disadvantage of a fluctuating temperature as compared to a constant mean temperature. And this influences appearance—not eating quality. This conclusion, however, is valid only for the temperature range studied. Flavor retention was about the same under either constant or fluctuating temperatures.

Turkeys were blast frozen and their quality deterioration studied over a period of 18 months as a function of temperature, temperature fluctuation, packaging, and scalding temperature. Experimental conditions included constant temperatures of −30°, −10°, 0°, and +10° F., and a temperature that fluctuated from −10° to +10° to −10° F. in a 24-hour period. This fluctuation is larger and more frequent than expected in normal commercial operations.

The wrappings were polyethylene bags, aluminum foil, or wax paper. In the impermeable wraps, moisture loss from the bird was deposited as frost inside the package. Frost formation was greater for the fluctuating temperature than for the highest constant temperature—10° F.

Turkeys scalded at 140° F. developed almost twice as much frost as birds that were scalded at 126° F.

Further studies are planned to determine the effect of temperature variation on quality of frozen poultry throughout the range of conditions found in commercial operations.☆

Potato flakes: precooking and texture

■ USDA SCIENTISTS have added a new step to the process for potato flakes—the new research product that makes delicious mashed potatoes as quickly as you can add hot milk or water (AGR. RES., February 1955, p. 12). By variation of the time and temperature of this new step—precooking—texture can be tailor-made from mealy to creamy and smooth.

This precooking permits use of low-solids potatoes, previously considered unsatisfactory. In addition, flakes prepared this way can take more reconstituting liquid than flakes prepared without precooking. This greater capacity to hold moisture may indicate changes in the cell content, probably in the physical properties of the gelled starch.

For precooking, the potato is heated in the range of 140° to 180° F. for a suitable time. Texture of the reconstituted product is controlled by adjusting this temperature and time. High temperature and short precooking time give a smooth, creamy mash; low temperature and a longer precooking give a dry, mealy mash.

The potato is next cooked at 212° F., diluted, sulfited (to prevent discoloration), mashed and then dehydrated in a double-drum drier.

Other factors also influence texture. Among these are flake size, moisture content, and flake thickness.

Flake size influences texture because broken cells on the periphery of the flake contribute free starch—in large enough quantity this would make the product pasty. The ratio of broken cells to number left intact increases as flake size is reduced.

Flakes of low moisture content yield reconstituted mashed potatoes of best texture. Low moisture content is obtained by diluting the mash before dehydration. The thinner mash adheres more closely to the drums and allows more thorough drying.

Flake thickness—controlled by clearance between the drier drums—also influences texture. If clearance is too small, starch is released from the cells and flakes are pasty when reconstituted. Too much clearance yields a flake with cell agglomerates difficult to dry and may result in a lumpy reconstituted mash.

ARS studies are in progress on the nature of these changes in the potato tissue. Results so far show that the two most important changes occurring during precooking are weakening of the cementing material between the potato cells, and gelatinization of the starch that's within these cells.☆

Potatoes are getting better

COOPERATIVE BREEDING PROGRAM PRODUCES SUPERIOR VARIETIES

TODAY'S potatoes are convincing examples of how progress is made through research. And some of the qualities that will make tomorrow's "spuds" even better are already in the stocks of potato breeders.

In 1910, when USDA's potato-breeding research began, average potato yield was 94 bushels an acre. Now, it tops 250 bushels, and breeders predict a 300-bushel average by 1975.

Early research emphasized development of varieties resistant to the destructive fungus disease late blight. Then about 1919, the work was broadened to include viruses.

Big strides have come since 1929, when USDA and 9 States joined in the National Potato-Breeding Program. Today, 32 States cooperate with ARS in this program, which has produced 40 new potato varieties—more than 20 of them still grown.

No variety yet released does well in all States, but each new potato has better characteristics for some area. Breeders aim for superiority in such factors as appearance, yield, market and cooking quality, solids content, and disease and insect resistance.

ARS potato breeder F. J. Stevenson says that high-yielding varieties not only mean enough potatoes for food but also help cut production costs. Commercial buyers and homemakers alike prefer a smooth, shallow-eyed potato that has thin, easy-to-peel skin. A potato with a higher percentage of solids (dry matter) supplies more nutrition and has better taste, no matter how it is prepared.

Resistance to late blight has been bred into Kennebec, Cherokee, Pungo and Essex, among today's leading varieties. To resist common scab, breeders have produced Menominee, Cherokee, Ontario, Seneca, and Cayuga. Resistance to one or more of the serious virus diseases has been developed in Katahdin, Chippewa, Houma, Sebago, and Kennebec. The Teton potato resists ring rot, and Sequoia resists hopperburn.

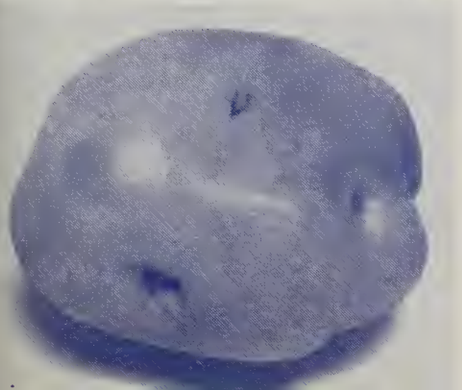
The aggressive program that has resulted in 40 superior varieties in 25 years has also armed breeders with a growing stockpile of outstanding potato plant characters yet to be combined. "Each new combination," Stevenson says, "should give us a potato variety more valuable to some growers than any we now have."

The research stockpile includes seedlings that are resistant to mild mosaic, late mosaic, veinbanding mosaic, leaf roll, net necrosis, yellow dwarf, late blight of vines, tuber rot (a disease initiated by the late-blight fungus), common scab, potato wart, ring rot, and hopperburn.

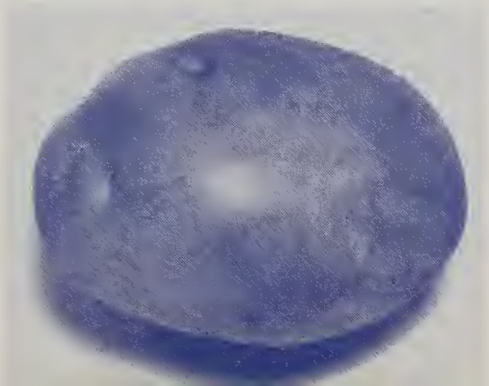
Other desirable traits in available stock include wide adaptability; early, medium, or late maturity; smooth, regular shape; shallow eyes; high yielding ability; and of course, excellent cooking quality.

Scientists are finding that the amount of solids in potatoes doesn't depend entirely on heredity (variety) but may be influenced even more by environment (soil type, or such cultural practices as fertilization, chemical treatment, planting and harvesting time). A variety that contains 25 percent solids when grown under one set of conditions may have only 15 percent under another. Better understanding of this heredity-environment relationship will undoubtedly result in better-quality potatoes.☆

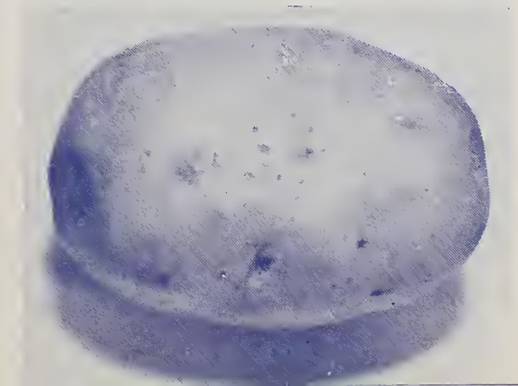
IRISH COBBLER, a long-time favorite variety, lacks important features of modern potatoes but still ranks second in acreage. It is susceptible to common diseases. Its deep eyes and high shoulders cause waste in peeling, make it difficult to wash clean of tight-clinging dirt. It is losing prestige.



KATAHDIN, developed in the potato breeding program 23 years ago, has led all varieties in production during last 9 years. It has resistance to mild mosaic, net necrosis, and brown rot diseases, and immunity to wart. Shallow-eyed and smooth-shouldered, it washes and peels easily, usually cooks well.

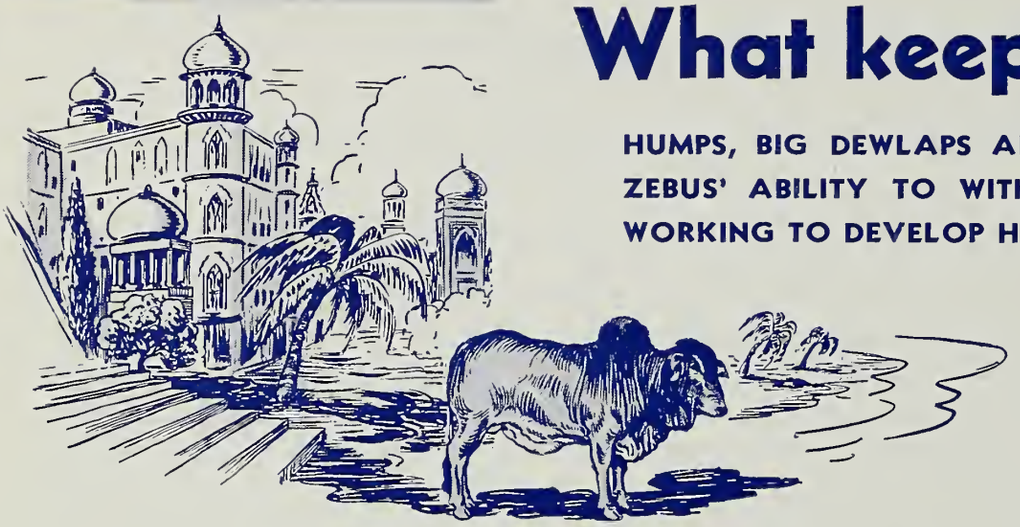


KENNEBEC, a newer variety, has large, well-shaped tubers with shallow eyes. It is good for baking, boiling, frying—makes excellent french fries and chips. It resists the common race of late blight, mild mosaic, and net necrosis. After 6 years in production, it grows on 80,000 acres, is gaining.



What keeps Zebus cool?

HUMPS, BIG DEWLAPS AND EARS DON'T ACCOUNT FOR ZEBUS' ABILITY TO WITHSTAND HEAT, SAY SCIENTISTS WORKING TO DEVELOP HOT-WEATHER-RESISTANT CATTLE



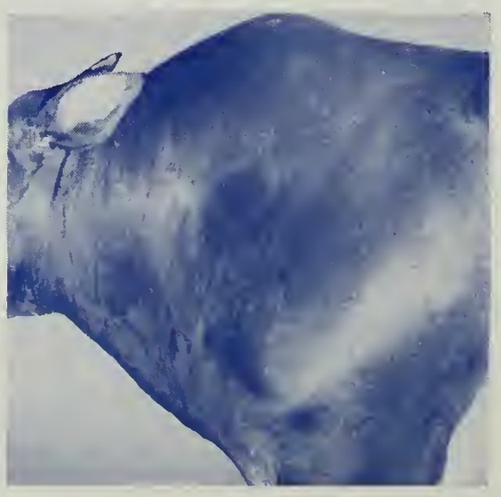
1. This Red Sindhi bull—with hump and big dewlap and ears—was used by researchers to test factors possibly responsible for the capacity of Zebu-type cattle to resist heat.

2. Removal of dewlap from this bull didn't change his ability to resist heat. This helped disprove theory that larger skin area of Zebus gives them greater heat tolerance.

3. Slaughtering the bull, researchers found hump has no heat-tolerance properties or muscular functions important to motion. It is fastened to shoulder blades by ligaments

5. Hump of a purebred Sindhi is located on withers and is centered about perpendicular to forelegs. Boneless, marbled meat in hump is good eating when properly prepared.

6. Less prominent in Sindhi-Jersey crossbred, the hump is found forward of the perpendicular of forelegs. But the internal fastenings are the same as in the purebred.



7. Born in May, this seven-eighths-Sindh bull calf will be used to cross-check the findings on the functions of humps, dewlaps and large ears as factors in heat tolerance

RESEARCHERS haven't found why Zebu-type cattle can stand more hot weather than European breeds, but USDA dairy scientists are convinced that characteristic Zebu humps, outsize dewlaps, and big ears have nothing to do with heat tolerance.

This is contrary to a long-held belief that such appendages—lacking in all European breeds—serve as "air-conditioning" equipment for dairy-type Sindhis and beef-type Brahmans. Reasoning was that the hump, the dewlap, and the large ears gave these Asiatic Sindhis and Brahmans a greater cooling area relative to size than European breeds possess.

Tests at the ARS Agricultural Research Center, Beltsville, Md., do not support this theory.

Sindhi and Brahman cattle are being widely used by Federal, State, and private researchers in an effort to develop heat-tolerant strains of dairy and beef animals for the Gulf Coast area and similar locations where tolerance to heat is important. (See AGR. RES., March–April 1953, p. 8; September 1955, p. 11.) A part of the task is to determine what factors are responsible for heat resistance in these exotic breeds.

Accordingly, one goal of the dairy-cattle research effort at Beltsville has been to find out whether the outward physical characteristics of Sindhi cattle are involved. This job began with the removal of the dewlap from a purebred Sindhi bull. Subsequent tests indicated the operation caused no change in the animal's ability to withstand the stress of heat.

More recently, this animal and a Sindhi-Jersey cross were slaughtered in order to dissect and study the hump of each animal. A heavy blood supply, researchers thought, might indicate that such an appendage could contribute to heat tolerance. But they found a normal supply of blood and nothing else save a well-marbled, boneless chunk of meat. (This meat, properly prepared, was as delectable as a standing-rib roast.)

Researchers found the hump of the purebred centered on the withers of the animal, perpendicular to the forelegs. On the crossbred, the hump was centered on the withers forward of the perpendicular of the forelegs. The humps in both animals, dissection revealed, were fastened by ligaments attached to the tops of the shoulder blades and separated from back and neck muscles by a layer of fat. There was nothing here to indicate that the humps possessed either heat-toleration or muscular functions.

These findings are now being cross-checked by dairy husbandman R. E. McDowell and associates. The researchers have placed a young seven-eighths-Sindhi bull calf under experiment. The hump was removed with the calf under general anesthetic when he was only a few weeks old. He is now a frisky young animal, awaiting the eventual removal of his dewlap and ear trimming(both relatively bloodless operations) to make him comparable to an ordinary calf of European breed. Tests will then be conducted to determine this bull's efficiency in heat tolerance.

Physical characteristics such as humps and dewlaps vary in crossbred cattle according to their proportion of Sindhi blood. To a lesser degree, there is also a variation in heat tolerance as Sindhi blood is increased or diminished. In halfbreed animals (Sindhi-Jersey, for example), large humps and dewlaps are easily discernible, and such crosses possess good heat tolerance. Hump and dewlap development are almost as well-defined in a three-quarter-blood Sindhi as in a purebred animal, but heat tolerance is only slightly better than in a halfbreed. A one-quarter-blood Sindhi retains little of the purebred's hump or dewlap, but heat tolerance is not greatly reduced from that of the halfbreed.

Researchers are continuing their investigation of all factors possibly responsibe for heat tolerance in Sindhi crossbreds. Eventually, breeding and selection can be undertaken and heat resistance passed along to more productive dairy animals.☆

4. Further dissection revealed that a layer of fat separates muscular tissue of the hump from back, shoulder, and neck muscles. This sectional view shows part of backbone.

3. His hump was removed; later dewlap will be taken off, ears trimmed. Then, with a skin area comparable to that of European breeds, he'll be tested for heat tolerance.

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OFFICIAL BUSINESS

agrisearch notes

FOLLOWING 22 YEARS in USDA, T. C. Byerly becomes assistant director of livestock research in ARS, succeeding H. C. McPhee, who retired.

Soon after completing his education in zoology, Dr. Byerly entered the Department as a physiologist. His early work was in poultry research. He also served as chief of the Animal Husbandry Division in the former Bureau of Animal Industry. Since reorganization of ARS, he has been chief of Animal and Poultry Husbandry Research Branch.

N. R. Ellis, veteran of 35 years research work in the Department, succeeds Byerly as chief of this branch. He started as a biochemist and has been in charge of animal nutrition studies for several years. Recently, he has directed work on meat production and quality.

FEEDING STILBESTROL to steers for faster gains didn't lower meat quality in preliminary tests at USDA's Agricultural Research Center, Beltsville, Md. That agrees with what several State experiment stations have reported but is contrary to what some people think.

Steers gain faster when stilbestrol, a hormone-like chemical, is fed in the finishing ration. The State researchers found no adverse effect from stilbestrol on carcass or meat quality. But it had been widely reported that the chemical caused "watery carcasses" or soft cuts.

This led to the Beltsville study. In a 90-day test, 5 steers were each given 10 milligrams of stilbestrol per day in the mixed-protein feed. That's the approved rate. (Stilbestrol is recommended for only 600-pound or heavier animals.) Five other steers were used as controls. The 10 weighed about 900 pounds each when the test began.

Steers on stilbestrol put on an average of about one-eighth pound a day more than the control animals—a 6-percent faster rate of gain.

At slaughter, both lots of steers averaged Low Choice in both live and carcass grades. The controls were slightly fatter, whereas those on stilbestrol had put on extra lean rather than fat—just as the State researchers had found. That was about the only difference.

Taste-panel tests of prime rib roasts from the two lots of steers showed that all the animals produced excellent meat. It graded moderately tender. Taste scores averaged 6 out of a possible 7 points.

An estimated 2½ million beef cattle were fattened on feed containing stilbestrol last spring—all of it ready-mixed at the feed mill.

THREE HOME ECONOMICS BRANCHES have been set up to strengthen this phase of USDA research. Work of the Human Nutrition Research Branch is continued and, in addition, two new branches—the Clothing and Housing Research Branch and the Household Economics Research Branch—have been created.

Establishment of the 3 branches closely follows recommendations of a 15-member home economics research advisory committee and will strengthen the ARS administrative organization for home economics research. In planning their work, the branches will take account of the committee's recommendations. As current studies are completed, the higher-priority proposals will get first consideration.

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